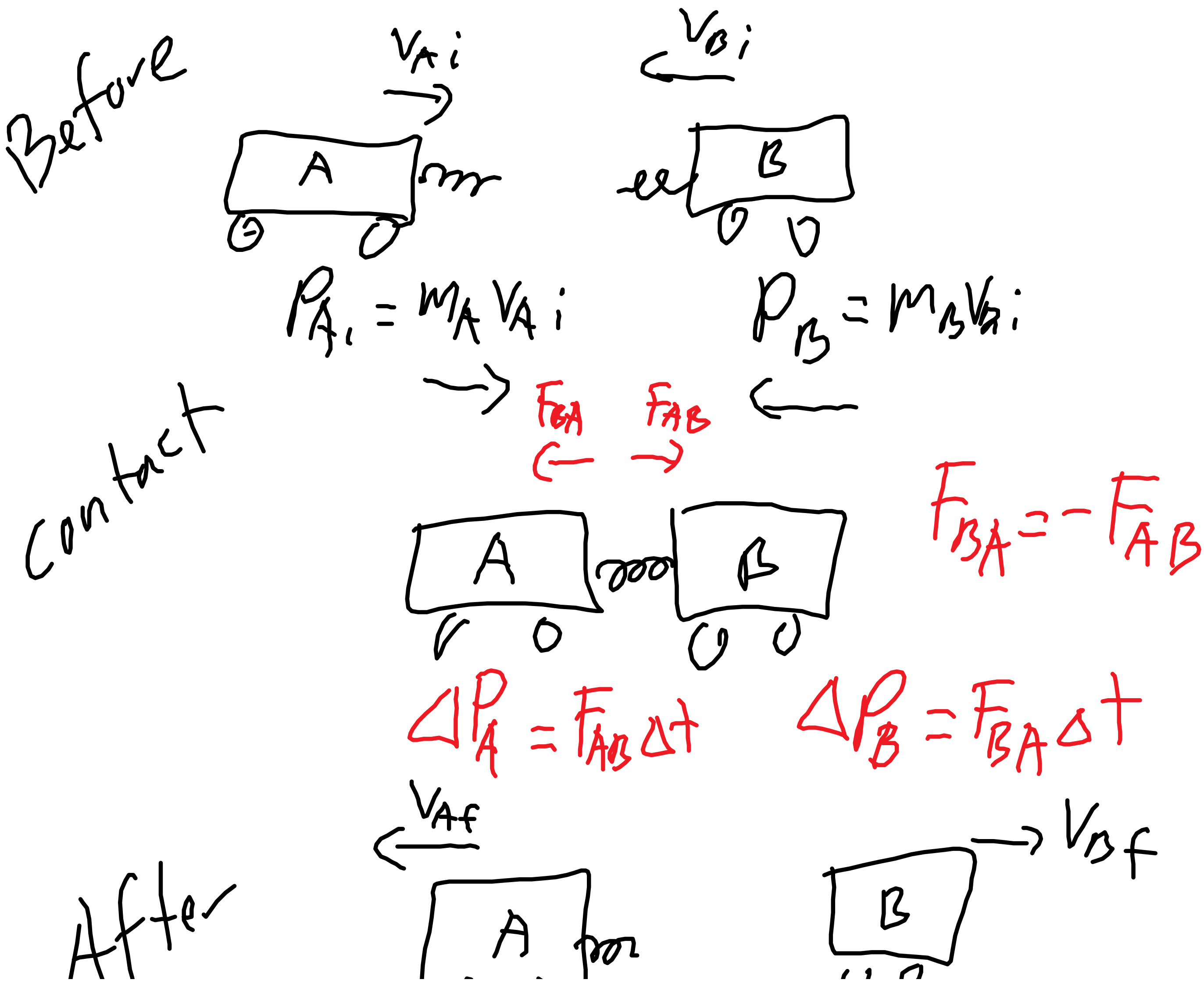
Law of Conservation of Momentum

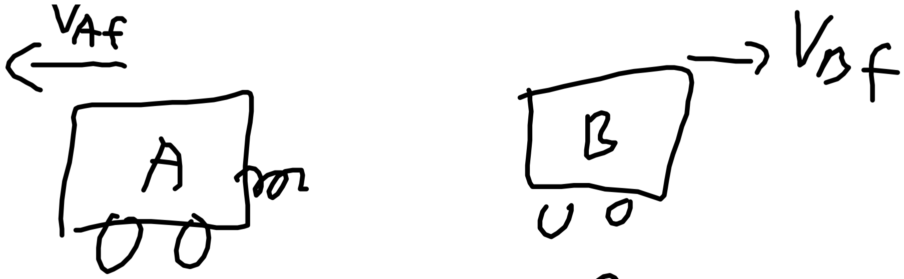
momentum is the product of mass and velocity
$p=mv$ units: kgm/s vector - direction

impulse is the change in momentum caused by a net force exerted through a time interval
$\Delta p=F_{net}\Delta t$ units: Ns or kgm/s
also the area under the F_{net} - t graph

Look at the collision of mass A with mass B or an explosion between mass A and mass B.



After



$$P_{Af} = m_A v_{Af} \qquad P_{Bf} = m_B v_{Bf}$$

$$\Delta P_A = F_{AB}\Delta t = (P_{Af} - P_{Ai})$$

sub in

$$\Delta P_B = F_{BA}\Delta t = P_{Bf} - P_{Bi} = -F_{AB}\Delta t$$

$$P_{Bf} - P_{Bi} = -(P_{Af} - P_{Ai})$$

$$P_{Bf} - P_{Bi} = -P_{Af} + P_{Ai}$$

$$P_{Bf} + P_{Af} = P_{Bi} + P_{Ai}$$

total momentum after the collision/explosion = total momentum before the collision/explosion

$$\Sigma P_f = \Sigma P_i$$

$$\Sigma p_f = \Sigma p_i$$

vector sum

so the vector sum of the momentum of the objects after the collision/explosion = the vector sum of the momentum before the collision

- momentum is conserved in a system with no external forces or objects in or out - closed, isolated system. The main source of error is frictional forces.

eg. A 3.0 kg cart is moving at 2.0 m/s when it collides with a 2.0 kg cart.
What is the velocity of the 3.0 kg cart and the impulse on the cart after the collision if

a) the 2.0 kg cart was at rest before the collision and moving at 1.5 m/s after the collision.
b) the 2.0 kg cart was at rest before the collision and it sticks to the 3.0 kg cart so they move off together.
c) the 2.0 kg cart was moving at -1.0 m/s before the collision and rebounds at +2.0 m/s after the collision.

procedure: draw a picture
calculate the total momentum before the collision. set up an equation with the momentum of all the objects after the collision.

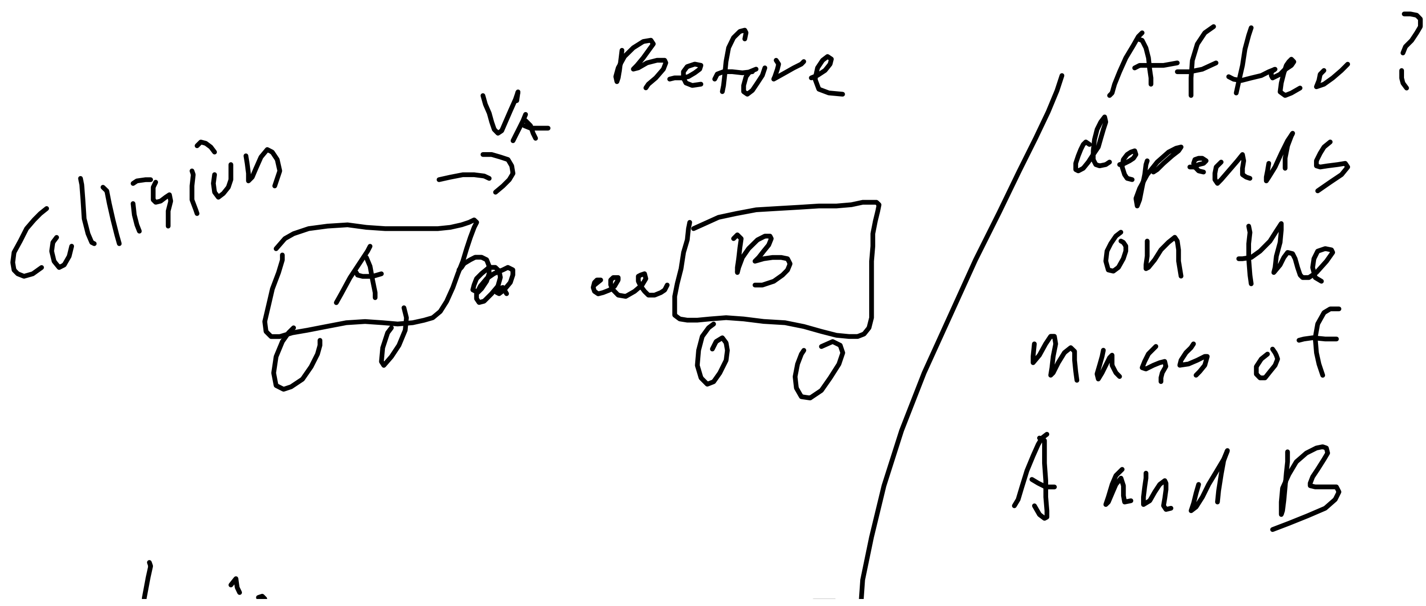
Solve for your unknown velocity.
impulse is the change in momentum of the object

Block 1-2
Collisions and Explosions

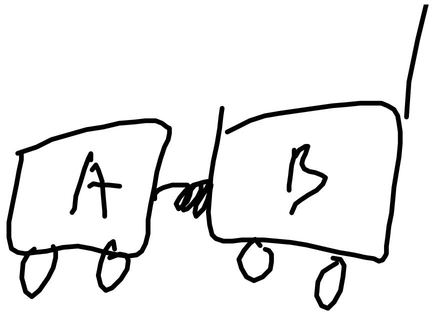
review: momentum and impulse
momentum, p, is the product of mass, m, and velocity, v.
$p=mv$ units: kgm/s vector -direction

impulse: the change in momentum caused by a net force acting over a period of time.
$\Delta p=F_{net}\Delta t$ units: Ns = kgm/s
area under the F_{net}-t graph

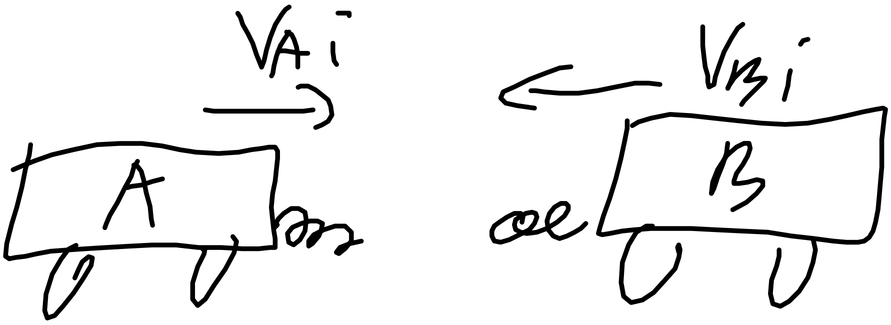
Let's look at the momentum and impulse of two objects, cart A and cart B, that collide or spring apart(explosion).



explosio

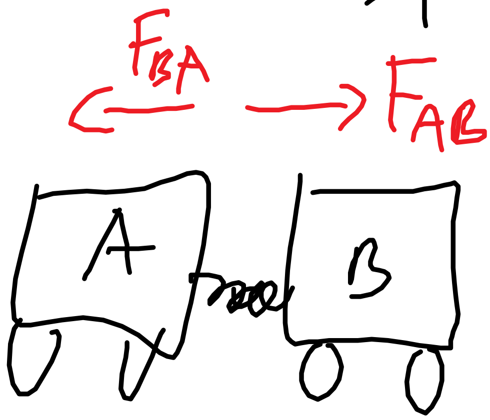


Before



$P_{Ai} = m_A V_{Ai}$ $\qquad$ $P_{Bi} = m_B V_{Bi}$

during contact



Newton's third Law

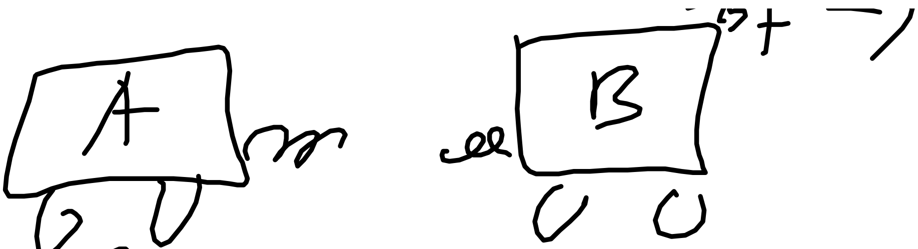
$F_{AB} = -F_{BA}$

$\frac{\Delta P_A}{\Delta t} = -\frac{\Delta P_B}{\Delta t}$

$\Delta P_A = -\Delta P_B$

$m_A \Delta V_A = -m_B \Delta V_B$

V_{Af} $\qquad$ V_{Bf}



$p_{Af} = m_A v_{Af}$ $\quad p_{Bf} = m_B v_{Bf}$

$$\Delta p_A = -\Delta p_B$$

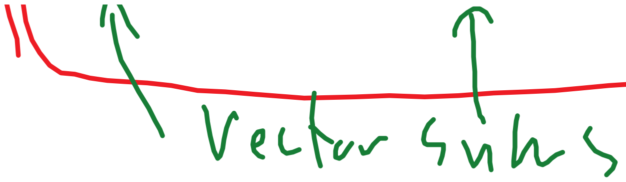
$$p_{Af} - p_{Ai} = -(p_{Bf} - p_{Bi})$$

$$p_{Af} - p_{Ai} = -p_{Bf} + p_{Bi}$$

$$p_{Af} + p_{Bf} = + p_{Ai} + p_{Bi}$$

total momentum of the system After the collision or explosion = total p Before collision/explosion

$$\sum p_f = \sum p_i$$



Law of conservation of momentum
the vector sum of the momentum of all the objects in a systems is conserved through collisions and explosions
assuming: no external forces or objects in/out - called a closed, isolated system.
usual source of error is friction